

What is claimed is:

1. A method of forming droplets, the method comprising:
5 flowing a liquid through a channel;
 spreading the liquid into a thin film in the channel; and
 impinging the thin film with a flowing gas to atomize the liquid into droplets
having a diameter less than 35 micrometers.
- 10 2. A method according to claim 1 wherein the thickness of the thin film is less
than 0.020 in.
3. A method according to claim 1 wherein the thickness of the thin film is less
15 than 0.005 in.
4. A method according to claim 1 wherein the liquid comprises a
pharmaceutical active agent.
5. A method according to claim 1 further comprising contacting the thin film
20 with a second flowing gas.
6. A method according to claim 1 wherein the thin film is cylindrically shaped.
7. A method of forming droplets, the method comprising:
25 flowing a liquid through a channel;
 spreading the liquid into a thin film; and
 impinging the thin film with a flowing gas to atomize the liquid into droplets,
the flowing gas impinging the thin film at a right angle.
- 30 8. A method according to claim 7 wherein the thickness of the thin film is less
than 0.020 in.

9. A method according to claim 7 wherein the thickness of the thin film is less than 0.005 in.

5 10. A method according to claim 7 wherein the liquid comprises a pharmaceutical active agent.

11. A method according to claim 7 wherein the thin film is cylindrically shaped.

10 12. A method of forming a pharmaceutical formulation, the method comprising:
flowing a liquid through a channel, the liquid comprising a pharmaceutical
active agent;
spreading the liquid into a thin film;
impinging the thin film with a flowing gas to atomize the liquid into
droplets; and
15 drying the droplets to form particles comprising the active agent.

13. A method according to claim 12 wherein the particles have a mass median diameter less than 20 μm .

20 14. A method according to claim 12 wherein the particles have a mass median diameter less than 10 μm .

15. A method according to claim 12 wherein the active agent comprises insulin.

25 16. A pharmaceutical formulation produced by a method comprising:
flowing a liquid through a channel, the liquid comprising a pharmaceutical
active agent;
spreading the liquid into a thin film;
impinging the thin film with a flowing gas to atomize the liquid into
30 droplets; and
drying the droplets to form particles comprising the active agent.

17. An atomizer for forming droplets, the atomizer comprising:
a first channel through which a liquid may flow, the channel comprising a
constriction for spreading the liquid into a thin film in the channel; and
5 a second channel through which an atomizing gas may flow, the second
channel being positioned so that the atomizing gas impinges the liquid thin film in a manner which
produces droplets having a diameter less than 35 micrometers.

18. An atomizer according to claim 17 wherein the constriction has a diameter
10 less than 0.020 in.

19. An atomizer according to claim 17 wherein the constriction has a diameter
less than 0.005 in.

20. An atomizer according to claim 17 further comprising a third channel
15 through which a gas may flow.

21. An atomizer according to claim 17 wherein the first channel is shaped so that
the thin film is cylindrically shaped.
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22. An atomizer for forming droplets, the atomizer comprising:
a first channel through which a liquid may flow, the channel comprising a
constriction for spreading the liquid into a thin film in the channel; and
a second channel through which an atomizing gas may flow, the second
25 channel being positioned so that the atomizing gas impinges the liquid thin film at a right angle to
produce droplets.

23. An atomizer according to claim 22 wherein the constriction has a diameter
less than 0.020 in.
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24. An atomizer according to claim 22 wherein the constriction has a diameter

less than 0.005 in.

25. An atomizer according to claim 22 wherein the first channel is shaped so that the thin film is cylindrically shaped.

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26. A spray drying system for forming a pharmaceutical formulation, the system comprising:

an atomizer, the atomizer comprising a first channel through which a liquid may flow, the channel comprising a constriction for spreading the liquid into a thin film in the channel, the atomizer further comprising a second channel through which an atomizing gas may flow, the second channel being positioned so that the atomizing gas impinges the liquid thin film to produce droplets;

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a drying chamber to dry the droplets; and
a collector to collect particles dried in the chamber.

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